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DOUGLAS-FIR BEETLE ATTACKS IN LIVING TREES AS INFLUENCED BY THE PRESENCE OF FRESH WINDTHROW

by

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Wright and Lauterbach (1958) gave conclusive evidence that tree killing by the Douglas-fir beetle (Dendroctonus pseudotsugae Hopkins) was associated with the buildup of beetle populations in windthrown trees. Logging of infested windthrown material has long been recommended as a method of controlling the Douglas-fir beetle. Hopkins (1909) and Hopping (1921) early emphasized the need for prompt removal of infested Douglas-fir from the woods. Others recommended removal of infested material during the year of infestation before the bark beetle broods emerge (Evenden and Wright, 1955; Walters, 1956; McCowan and Rudinsky, 1958; Furniss, 1959). No authority has specifically recommended that freshly felled or windthrown timber be removed before it becomes infested. Walters (1956) warned that if logging did not soon follow the felling of trees in early spring or summer, adjacent stands should be carefully watched for infestation. Johnson, et al, surmised that beetles making a second attack were responsible for infestation of living trees found attacked in the vicinity of fresh windthrow. Now, evidence from two years' observations on the McDonald Tree Farm in southwestern Washington indicates that freshly felled Douglas-fir attract Douglas-fir beetles which, once in the area, will attack nearby living trees, as well as the down material. Substantiation of this hypothesis would permit a new approach to reducing losses caused by Douglas-fir beetles.

METHODS

In the spring of 1960, 22 wind-damaged trees were located in about

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15 acres of a 100-year old stand of Douglas-fir at McDonald Tree Farm. Damage, which had occurred the previous winter, included both uprooting of trees and breaking of the trunk below the crown. Two additional trees were purposely felled and five 1-foot sections from one of these placed next to five standing, uninfested trees.

Shortly after the peak of Douglas-fir beetle flight, all down material and standing trees in the vicinity were examined for fresh Douglas-fir beetle attacks. Distance from the nearest point on the bole of down trees to each standing tree within 15 feet was measured and recorded in one-foot distance classes. Since beetle attacks usually occur between the root collar and a 5-inch top, only this portion of the bole of the down tree was considered. Standing trees between 15 and about 30 feet of the down material were examined for beetle attacks, but distances were not measured. Number of beetle attacks per square foot of bark surface was determined for the down material and for each standing tree at a height about level with the down tree. In all, 144 standing trees around the 22 wind-damaged trees were examined. The number of trees per distance class ranged from 6 to 16.

RESULTS

Number of attacks per square foot on standing trees was greatest on the trees nearest the down material, decreasing with increasing distance (Fig. 1). The regression, number of attacks per square foot = $4.3 - 0.63\ (\text{Dist.}) + 0.025\ (\text{Dist.}^2)$, fits the data reasonably well with a highly significant correlation coefficient of .61. The regression showed that standing trees at zero distance from the down logs had 4.3 attacks per square foot, compared to an average of 5.7 for the down material. Standing trees at 12.6 feet (where the curve is at a minimum) have only 0.3 attacks per square foot. Thus, it appears that beetles attack nearly indiscriminately in the immediate vicinity of down trees. All trees up to three feet distant were attacked (Fig. 2). Only three trees beyond 15 feet of down material were found to have been attacked. One of these was at 25 feet, and one at 30 feet. The third was remote from recent down material but was adjacent to a year-old windfall. The tree had been partially girdled and weakened by a beetle attack the previous season. It may have been serving as its own source of attraction to the current crop of beetles.

Attacks were recorded in both standing trees and the adjacent one-foot blocks within five days after the blocks were placed near the trees (Fig. 3). Further, the standing trees near the purposely felled trees were attacked (Fig. 4). Of the trees attacked in this study, 15 were killed as was revealed by re-examination in the spring of 1961. Beetle galleries were abortive in those attacked trees which did not die.

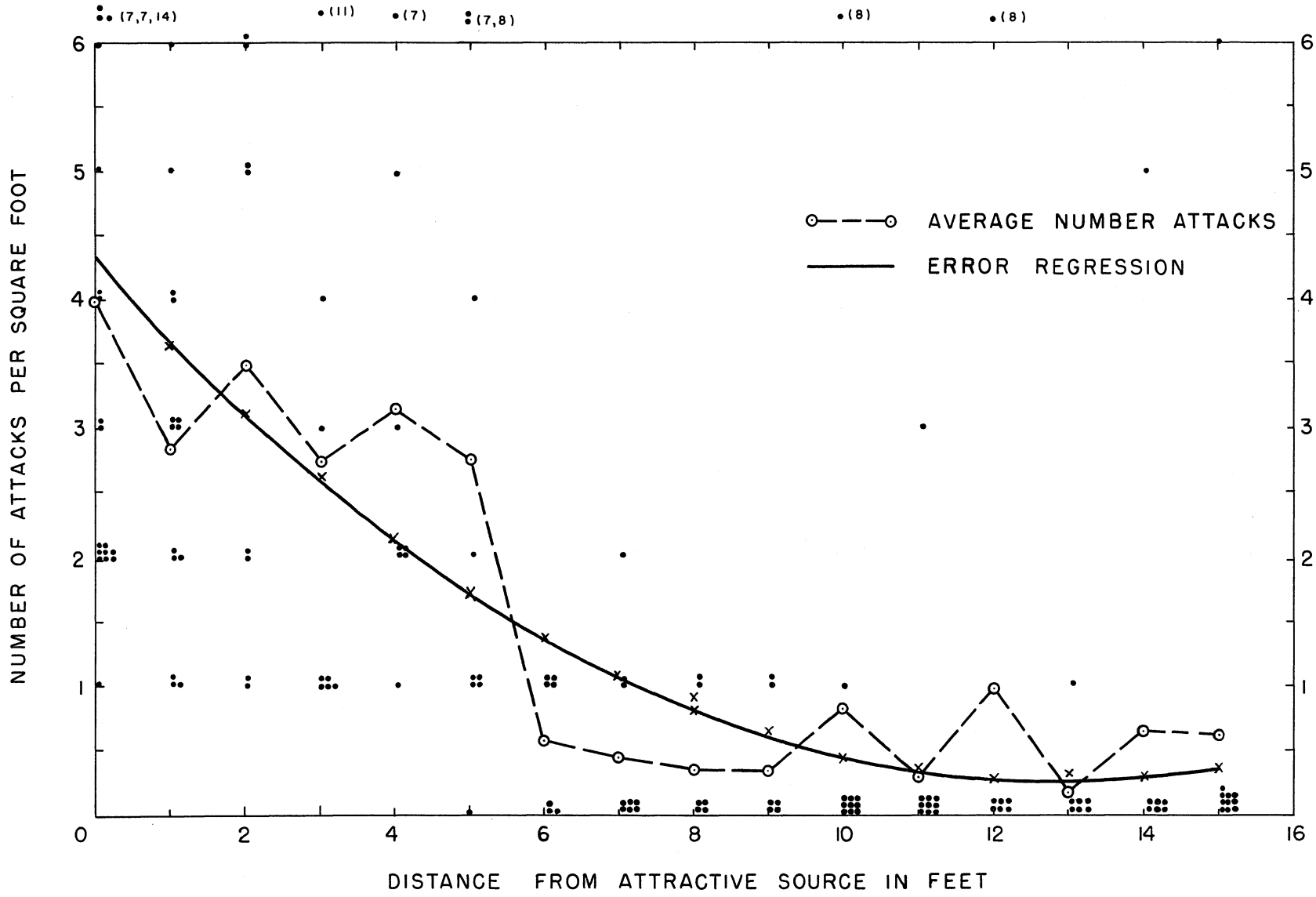

Fig. 1. – Relationship between attack density on standing trees and distance to nearest attractive source.

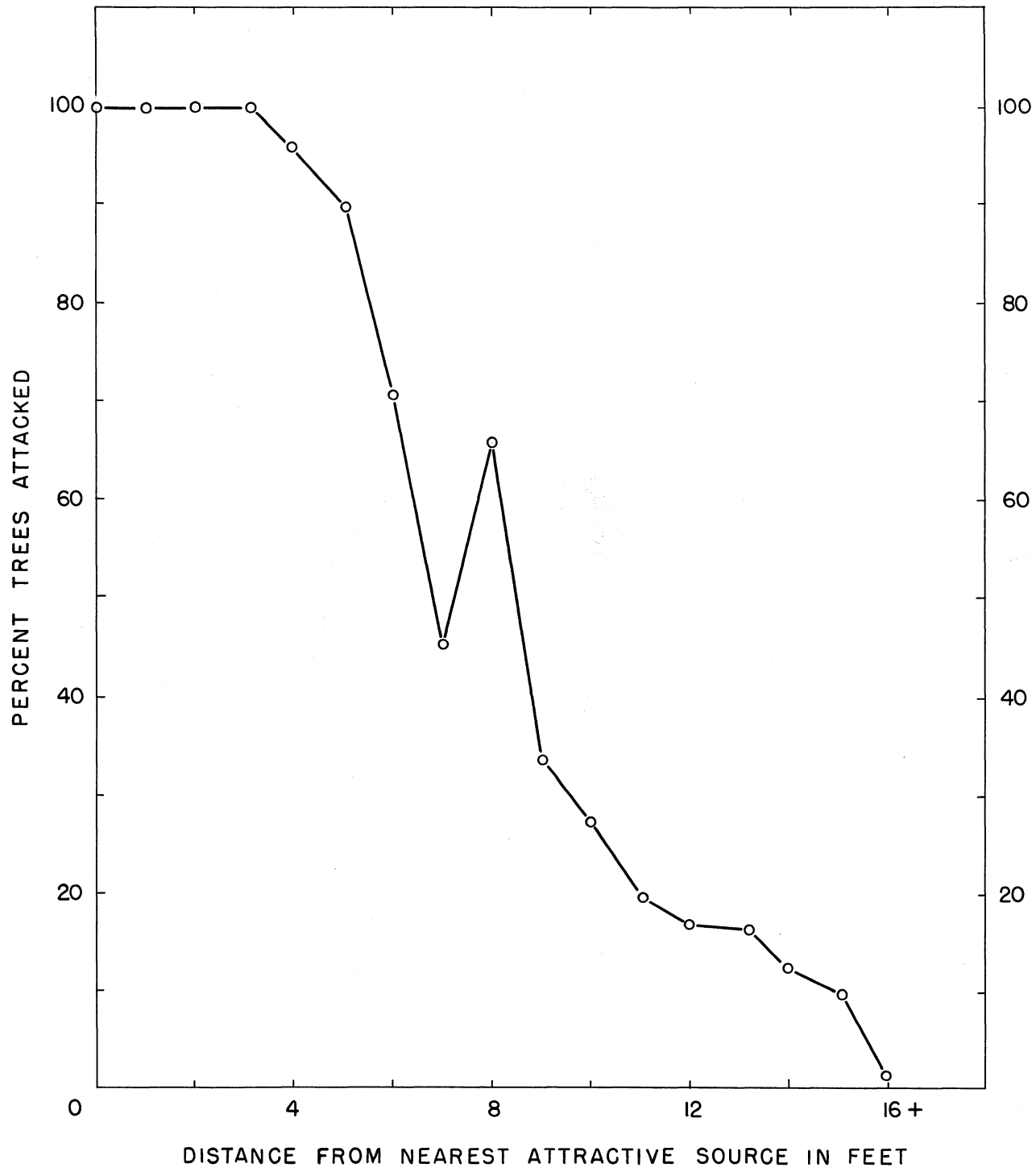

Fig. 2. – Relationship between the percent of standing trees attacked by the Douglas-fir beetle and the distance to the nearest source of attraction.

Fig. 3. – One foot block of fresh Douglas-fir used to attract beetles to living tree on right (attacks marked with nails).

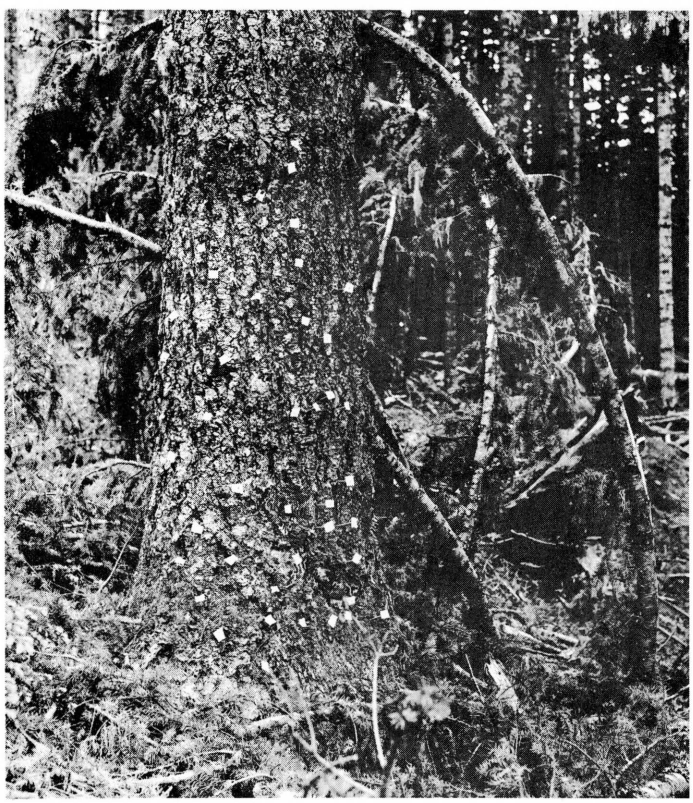

Fig. 4. – Attacks of Douglas-fir beetle (marked with tags) in a standing tree that is in contact with a freshly felled tree.

DISCUSSION AND CONCLUSIONS

Explanation of the simultaneous attack of felled trees and nearby living trees lies in the field of host attraction. Entomologists have for years tried to determine the factors which attract a bark beetle to its host. The answer is still not clear. Most workers feel that the guiding sense is olfactory, but disagree on the source of attraction. Odors caused by fermentation of the phloem tissues in the presence of yeasts have been proposed as a possibility. Some suspect certain odoriferous substances in the tree itself, such as volatile esters and aldehydes formed by factors interfering with the normal physiology of the tree. Whatever the cause, it is apparent from this study that down logs attracted the beetles. Once in the vicinity they attacked the logs and standing trees indiscriminately. It is possible that down logs create an "area of attractive odor" which diminishes with distance from the source. Thus, the intensity of attack and the proportion of trees attacked diminishes with increased distance. Additional evidence for this theory was noted where trees of several species were felled together. Western hemlock and western redcedar logs contiguous to Douglas-fir logs were commonly attacked. However, logs of Douglas-fir that were felled longer than one year were not attacked even though a fresh Douglas-fir log was nearby.

Schwerdtfeger (1960) offers evidence for the "area of attraction" idea. He found that Dendroctonus adjunctus commonly attacked apparently healthy pine if the trees were in the immediate vicinity of recently felled trees. Schwerdtfeger shows that D. adjunctus is not a secondary pest that must wait for trees to be weakened before attacking.

Concentration of attacks around freshly fallen trees would indicate that tree mortality from beetle attack is directly proportional to the amount of windfall or attractive material. Beetle populations are extremely variable and heaviest tree mortality seems to occur in years following heavy windthrow, rather than in the same year. Disregarding factors of weather and host condition, the variation may be explained by the relative abundance of beetles and windthrow. Following catastrophic windthrow, beetles seek out the down trees and in the process attack great numbers of standing trees. At this stage, because of the extreme number of attracting trees in relation to the beetle population, the intensity of attack is too low to cause much tree mortality. Beetle population does, however, build up tremendously in the windthrow. If the amount of fresh windthrow is more nearly normal in the following year, the large beetle population will attack both standing and down trees in force. Heavy infestations on the standing trees results in increased mortality.

Thus, if the beetle populations are low and the amount of windthrow is high, little mortality will occur from infestations that year. When the beetles are abundant in relation to the amount of windthrow, scattered tree mortality will occur as the beetles concentrate around the windthrow and attack neighboring trees. During years of high beetle populations and large amounts of fresh windthrow, however, epidemics may occur. One might question whether the beetles attacked the standing trees simultaneously with the attacks on the windthrow, or whether they attacked the windthrow first with a few beetles emerging later to attack the nearby standing trees. The period of time between time of attack and period of examination was short and thus indicates simultaneous attack. In addition, two trees with freshly cut log-sections placed next to them had six and seven attacks respectively while the log sections had 1 and 0 attacks. Thus, the beetles could not have attacked the sections first and later emerged to attack the standing trees.

For practical purposes, the results of this study show the importance of removing windthrown and felled timber in the spring and early summer prior to infestation by bark beetles.

SUMMARY

Fresh windthrow or freshly felled Douglas-fir trees apparently attract Douglas-fir beetles, which once in the immediate area attack indiscriminately the down timber which attracted them and standing trees. All standing trees three feet or less from a freshly downed tree were found to be attacked in the 100-year old stand studied. Intensity of attack decreased with distance from the down, attractive trees. Attacks were induced in standing trees by placing one-foot sections of fresh Douglas-fir next to the tree. If fresh windthrow is removed from the woods prior to spring flight of the Douglas-fir beetle, tree killing may be reduced in the immediate vicinity, especially in years of high beetle populations.

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